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FARMERS' KNOWLEDGE ON THE ROLE OF SHADE TREES IN COFFEE BASED AGROFORESTRY SYSTEMS IN PROVISION ECOSYSTEM SERVICES

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Introduction

Indonesia is the 4th largest coffee exporter in the world (Ditjenbun, 2004), most of coffee producers are small-scale farmers. Most of them own less than 0.5 to 1.5 hectares. These farmers are faced with the fact declining coffee prices in the international market. Therefore farmers have to find an alternative solution solving economic needs than rely on coffee production. One common practice among coffee growers is to plant shade trees. Farmers' knowledge on coffee shade tree species largely determines the vegetation structure, tree diversity and the provision of ecosystem services of coffee agroforestry. In order to establish promising trees for the diversification of coffee systems, farmers' goals and selection criteria must be explored. Farmers have considerable knowledge about the trees found growing in their fields. This study was therefore conducted to understand farmers' preferences and selection criteria for coffee shade trees. This study aimed to analyze the relationship between farmers' knowledge about coffee shade tree species in the study area in relation to ecosystem services in coffee agroforestry.

Keywords: Farmers knowledge, shade trees, ecosystem services, Agroforestry coffee based

Materials and Methods

The study was conducted on simple shade coffee plantations and coffee multistrata in Ngantang, Malang, East Java, Indonesia. Information regarding farmers' perception and criteria for shaded trees and its association with vegetation diversity and ecosystem services provided was studied using in-depth interviews and field survey. Tree biomass was measured using allometric equation. Earthworm was taken using soil monolith (25 cm x 25 cm x 30 cm), method introduced by Anderson and Ingram (1989). Diversity and population of earthworms were identified based on an external identifier worm body.

Results and Discussion

Indepth interview showed that farmers planted shade trees based on several considerations, such as (1) the ability of shade trees to provide organic matter, (2) tree covered area, (3) the use of tree leaves as fodder and (4) the economic value of the trees. Gamal (*Gliricidia sepium*) was a highly favored tree species as coffee shade, followed by banana, avocado, and durian.

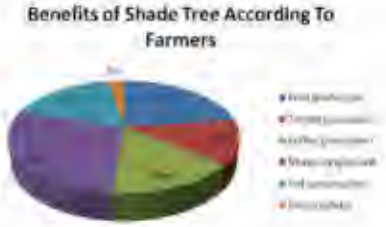

Figure 1. Benefits of shade trees in coffee agroforestry based on the perception of farmers interviewed (n = 20)

Coffee multistrata had higher species (shade) tree diversity and greater ecosystem services, as well as tree biomass and soil carbon (C) stocks (26.3 Mg ha^{-1} and 76.7 Mg ha^{-1}, respectively).

Figure 2. (A) Carbon reserves of the various components of the coffee plantation (B) Contribution to the coffee plantation trees in carbon stocks

However, not so with the diversity and populations of earthworms, density, and biomass of earthworms (simple shade coffee was 156 indiv. m^{-2}, 22.1 g m^{-2}, and 7 species, respectively, whereas in multistrata coffee was 125 indiv. m^{-2}, 32.0 g m^{-2}, and 7 species). Dominant worm species was found in both types of coffee plantations were *Pontoscolex corethrurus* (endogeic) and *Peryonix excavatus* (epigeic). Constant infiltration in both coffee agroforestry systems were no different, (infiltration at coffee multistrata was 31.4 cm hr^{-1} and at simple shade coffee was 40.2 cm hr^{-1}).

Conclusions

Farmers selection of shade trees in coffee agroforestry is determined by the economic value of trees, nutrient and moisture requirements, litter biomass, leaf utilization for fodder, the ability to improve soil fertility, as well as the amount of shade. Ecosystem services are determined by diversity of species. Multistory coffee provide greater benefits, as well as tree biomass and its C-stock (26.3 Mg ha^{-1} and 76.7 Mg ha^{-1} respectively) as well as the diversity of earthworms.

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